2018
WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE

Program and Abstracts

April 19, 2018
Rushmore Plaza Civic Center
Rapid City, South Dakota

With optional field seminars/trips
April 20, 2018

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2018 Western South Dakota Hydrology Conference

This program and abstracts book has been produced in conjunction with the 2018 Western South Dakota Hydrology Conference (16th annual), held at the Rushmore Plaza Civic Center on April 19, 2018. The purpose of this book is to provide summaries of the presentations made during the meeting.

The purpose of the 2018 Western South Dakota Hydrology Conference is to bring together researchers from Federal, State, University, local government, and private organizations and provide a forum to discuss topics dealing with hydrology in western South Dakota. This meeting provides an opportunity for hydrologists, geologists, engineers, scientists, geographers, students, and other interested individuals to meet and exchange ideas, discuss mutual problems, and summarize results of studies. The meeting consists of four technical sessions, several keynote speakers, the John T. Loucks Distinguished Lecture, and a poster session. The topics of the technical sessions include invited speakers; changes and discoveries; water quality and monitoring; groundwater; emergency response; geomorphology; and hydrology potpourri.

ACKNOWLEDGMENTS

Many people have contributed to this meeting. The many presenters are thanked for their contributions. The moderators are thanked for their help in streamlining the technical sessions. The help by many students from the South Dakota School of Mines and Technology with presentations and lights is greatly appreciated. The invited speakers, James Rankin, Daniel Soeder, James Rattling Leaf, Sr., Alan Anderson, and Jeff Crockett, are thanked for their time and perspectives. Registration help by Sheri Meier and Misty Mandas (USGS) is greatly appreciated. Josh Lee and Kristin Adkins (USGS) provided computer support for the meeting.

The organizing agencies are thanked for support: National Weather Service, RESPEC, South Dakota Department of Environment and Natural Resources, South Dakota School of Mines and Technology, U.S. Geological Survey, and West Dakota Water Development District. The West Dakota Water Development District is thanked for sponsoring the John T. Loucks Distinguished Lecture. RESPEC is thanked for being the Executive Sponsor. The many vendors are thanked for their support of the conference. Citizens' Climate Education and HDR Engineering is thanked for sponsoring the breaks. The chairpersons for this meeting were Melissa Smith (National Weather Service), Lacy Pomarleau (RESPEC), Joanne Noyes (South Dakota Department of Environment and Natural Resources), Scott J. Kenner (South Dakota School of Mines and Technology), Liangping Li (South Dakota School of Mines and Technology), J. Foster Sawyer (South Dakota School of Mines and Technology), Daniel Soeder (South Dakota School of Mines and Technology), Galen Hoogestraat (U.S. Geological Survey), Joyce Williamson (U.S. Geological Survey), Janet Carter (U.S. Geological Survey), and Daniel Driscoll (U.S. Geological Survey).

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RESPEC CONFERENCE PRESENTATIONS

Environmental Monitoring: Applying Advancements in Instrumentation to Overcome Unique Challenges (11:00-11:20 a.m.)

Municipal Watershed Wildfire Hazard Mitigation Assessments (1:30-1:50 p.m.)

Waldo Canyon Fire Impacts to US 24 & Emergency Response Plan (1:50-2:10 p.m.)

2018 WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE PROGRAM

Thursday, April 19, 2018
Alpine/Ponderosa Rooms and Rushmore F and G
Rushmore Plaza Civic Center

7:00 – 8:00 a.m.	**REGISTRATION**	
8:00 – 10:00 a.m.	**Plenary Session 1 in Alpine and Ponderosa Rooms – Invited Speakers (2.0 PDH)** **Moderator – Joyce Williamson**, U.S. Geological Survey	
8:00 – 8:10 a.m.	Welcome, general information	**Joyce Williamson**, U.S. Geological Survey
8:10 – 8:20 a.m.	Opening remarks	**James Rankin,** President, South Dakota School of Mines and Technology
8:20 – 9:00 a.m.	Groundwater quality and fracking: current understanding and science needs	**Daniel Soeder**, Energy Resources Initiative, South Dakota School of Mines and Technology
9:00 – 9:30 a.m.	Facilitating tribal climate change adaptation planning and communicating climate change impacts in the Great Plains	**James Rattling Leaf, Sr.**, Coordinator, Climate Partnerships - Great Plains Tribal Water Alliance
9:30 – 10:00 a.m.	A brief status report - a changing climate	**Alan D. Anderson**, NOAA Commissioned Corps and U.S. Forest Service (Retired)
10:00 – 10:20 a.m.	**REFRESHMENT BREAK in Rushmore G – Sponsored by Citizens Climate Education**	
10:20 a.m. – 12:00 p.m.	**Concurrent Session 2A in Alpine Room – Changes and Discoveries (1.5 PDH)** **Moderator – Dan Driscoll**, U.S. Geological Survey	**Concurrent Session 2P in Ponderosa Room – – Water Quality and Monitoring (1.5 PDH)** **Moderator – Megan Burke**, RESPEC
10:20 – 10:40 a.m.	*Understanding the relation between energy and water in the Williston Basin* **– Joanna Thamke,** U.S. Geological Survey	*The impact of mountain pine beetle infestation on surface water quality within the Upper Rapid Creek watershed of the Black Hills National Forest* **– Jesse Punsal, James Stone, Heidi Sieverding, and Scott Kenner**, SDSM&T, **Chuck Rhoades and Timothy Fegel**, U.S. Forest Service
10:40 – 11:00 a.m.	*Using multi-physics and multi-model regional climate model ensembles to assess climate resiliency in the Great Plains* – **Bill Capehart***,* South Dakota School of Mines and Technology	*Blue Dog State Fish Hatchery (SFH) water quality improvements* – **Allan Erickson***,* HDR Engineering, Inc.
11:00 – 11:20 a.m.	*Change-point analysis for nationwide peak streamflow* – **Karen Ryberg, Glenn Hodgkins, and Robert Dudley,** U.S. Geological Survey	*Environmental monitoring: applying advancements in instrumentation to overcome unique challenges* **– Pete Rausch,** RESPEC
11:20 – 11:40 a.m.	*Using surface and subsurface geology to estimate the true elevation of subterranean lakes at Jewel Cave, South Dakota* **– Mike Wiles, Eric Fiorentino, Gabriella Cerrati, Erin Hayward,** Jewel Cave National Monument, and **Daniel Heins,** University of Chicago	*Rapid deployable real-time monitoring technology for water resource data collection* – **Dave Hisz,** *North Dakota State Water Commission*
11:40 – 12:00 p.m.	*Determination of the potential for detection and monitoring of brine spills in rangeland using remote sensing* – **Patrick Kozak, Liangping Li, Bill Capehart, Heidi Sieverding, and James Stone**, SDSMT	*The path forward – insight from directed stakeholder discussion at the 2017 Eastern South Dakota Water Conference* **– John McMaine, David Kringen, and Rachel McDaniel,** South Dakota State University
12:00 p.m. – 1:30 p.m.	**LUNCH in Rushmore F Room (1.0 PDH) –** with accompanying presentations **RESPEC: Jason Love** **John T. Loucks Distinguished Lecture** – "Colorado Springs utilities water treatment section response to the Waldo Canyon Fire" by **Jeff Crockett**, City of Rapid City Water Superintendent	
1:30 – 3:10 p.m.	**Concurrent Session 3A in Alpine Room – Emergency Response (1.5 PDH)** **Moderator – Melissa Smith**, NOAA/National Weather Service	**Concurrent Session 3P in Ponderosa Room – Groundwater (1.5 PDH)** **Moderator – Joanne Noyes**, South Dakota Department of Environment and Natural Resources
1:30 – 1:50 p.m.	*Municipal watershed wildfire hazard mitigation assessments* – ***Megan Burke,*** *RESPEC*	*Groundwater conditions in the Ararat Basin in Armenia*– **Janet Carter, Josh Valder, and Mark Anderson**, U.S. Geological Survey

1:50 – 2:10 p.m.	*Waldo Canyon Fire impacts to US 24 & emergency response plan* **– Richard Ommert and Dorothy Eisenbraun,** RESPEC	*Airborne electromagnetic (AEM) surveys of buried aquifer deposits in North Dakota,* **Rex Honeyman**, North Dakota State Water Commission
2:10 – 2:30 p.m.	*Climate and weather conditions governing the explosive growth of the Legion Lake wildfire*– **Darren Clabo,** South Dakota State Fire Meteorologist, SDSMT	*Numerical simulation of groundwater flow in the High Plains aquifer system in southern South Dakota and northern Nebraska***– Kyle Davis and Bill Eldridge,** U.S. Geological Survey
2:30 – 2:50 p.m.	*Christmas Lake dam hydraulic analysis and redesign***– T.J. Yerdon and Dennis Reep,** HDR Engineering, Inc.	*Tritium and carbon-14 dates in the Madison limestone aquifer, Black Hills area, South Dakota* **– Perry Rahn,** South Dakota School of Mines and Technology
2:50 – 3:10 p.m.	*Biofilm engineering approaches for improving the performance of bioelectrochemical systems for bioremediation of industrial effluents* – ***Navanietha Krishnaraj Rathinam and Rajesh K. Sani,*** South Dakota School of Mines and Technology	*Evaluation of streamflow depletion related to groundwater withdrawals in the Humboldt River Basin, Nevada* – **Bill Eldridge, Kyle Davis, Kip Allander, C. Justin Mayers, Cara Nadler, Murphy Gardner, and Michael Pavelko,** USGS
3:10 – 3:30 p.m.	**REFRESHMENT BREAK in Rushmore G – Sponsored by HDR Engineering**	
3:30 – 4:30 p.m.	**Concurrent Session 4A in Alpine Room – Geomorphology (1.0 PDH)** **Moderator – Lacy Pomarleau**, RESPEC	**Concurrent Session 4P in Ponderosa Room – Hydrology Potpourri (1.0 PDH)** **Moderator – Janet Carter**, U.S. Geological Survey
3:30 – 3:50 p.m.	*Developing a hydrologic model to study the effects of habitat restoration and the change in habitat on aquatic life* – **Mackenzie Kenney, Stu Geza, and Scott Kenner**, SDSM&T, and **Jake Davis**, S.D. Department of GF&P	*The complexity of water supply conveyances* **– Benjamin York and Kathleen Rowland,** U.S. Geological Survey
3:50 – 4:10 p.m.	*Bank accretion in the Green River (Utah) downstream of the Flaming Gorge Dam and Yampa River confluence* – **David Waterman**, South Dakota School of Mines and Technology	*Subsurface cave detection in Wind Cave National Park using microgravity surveying techniques* – **Colton Medler and Bill Eldridge,** U.S. Geological Survey
4:10 – 4:30 p.m.	*Comparison of geomorphic properties between functional process zones in the Great Basin* – **John Costello and Scott Kenner**, SDSM&T, **Nicholas Kotlinski**, Chicago Field Museum, and **James Thorp**, University of Kansas	*Site scale integrated decision support tool (i-DST) for stormwater management* **– Ali Shoajeizadeh and Stu Geza,** SDSM&T**, Colin Bell, Terri Hogue, John McCray,** Colorado School of Mines
4:30 – 7:00 p.m.	**POSTER SESSION AND EVENING SOCIAL (with refreshments) in Rushmore G** **Sponsored by Energy Laboratories and Citizens Climate Education** **Moderator – Galen Hoogestraat,** U.S. Geological Survey	
	Modeling groundwater flow by coupling ensemble smoother and direct sampling method – **Zhendan Cao** and **Liangping Li**, South Dakota School of Mines and Technology	
	Dynamics of temperature, flow, and thermal refuge with implications on fisheries and macroinvertebrates in Rapid Creek – **Michaela Halvorson, Lisa Kunza,** South Dakota School of Mines and Technology, and **Jake Davis**, SDGF&P	
	Examining streamflow losses along White River near Oglala, South Dakota – **Ryan Puzel, Liangping Li, and J. Foster Sawyer**, South Dakota School of Mines and Technology	
	Investigating nutrient distribution and land use in the Kootenai River Basin – **Emily Stickney** and **Lisa Kunza**, South Dakota School of Mines and Technology	
	Water quality comparison of two water years at Niobrara National Scenic River – **Darren Thornbrugh**, National Park Service	
	Soil column experiment and modeling nitrogen fate and transport from on-site rural septic systems in the South Dakota, Black Hills Area – **Raul Vasquez**, South Dakota School of Mines and Technology	
	The impacts of land use and land cover change on water quality in the Big Sioux River: 2007-2016 – **Dinesh Shrestha and Darrell Napton,** South Dakota State University	
	Genome to phenome relationships for improving the performance of bioelectrochemical systems – **Navanietha Krishnaraj Rathinam, Pratha Sood, and Rajesh Sani,** South Dakota School of Mines and Technology	
	Fate and transport of antineoplastic agents: detoxification mechanisms in drug-resistant microorganisms – **Navanietha Krishnaraj Rathinam, Dipayan Samanta, and Rajesh Sani,** South Dakota School of Mines and Technology	
	Application of Drainage Water Management and Saturated Buffers for conservation drainage in South Dakota – **Abhinav Sharma, Rachel McDaniel, Todd Trooien,** South Dakota State University	
	Development of a Groundwater Management Plan for the City of Aberdeen, SD – **Fleford Redoloza and Liangping Li,** South Dakota School of Mines and Technology	

Optional Field Seminars/Trips
Friday, April 20, 2018
(PRE-REGISTRATION REQUIRED)

Times	Field Seminar/Trip
9:00 a.m. – 12:00 p.m.	Tour of South Dakota School of Mines and Technology campus and laboratories – **various faculty**, SDSM&T (3.0 PDH)
8:30 – 11:30 a.m.	Rapid Creek in-stream fish habitat improvement projects – **Jake Davis and John Carriero**, SDGFP (3.0 PDH)
7:30 a.m. – 12:00 p.m.	Jewel Cave National Monument geology tour – **Mike Wiles**, National Park Service (3.0 PDH)
8:30 – 11:30 a.m	Orchard Meadows Subdivision drainage improvements – Michael Towey, Kyle Treloar, and Mike Stetson (**KTM Design Solutions**) (3.0 PDH)

THURSDAY, APRIL 19, 2018
SESSION 1
8:00 – 10:00 A.M.

INVITED SPEAKERS
(ALPINE/PONDEROSA ROOMS)

GROUNDWATER QUALITY AND FRACKING: CURRENT UNDERSTANDING AND SCIENCE NEEDS

Daniel J. Soeder
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Over the past two decades, shale gas and tight oil development has opened up vast new reserves of fossil energy in North America. However, the drilling and hydraulic fracturing or "fracking" processes that are necessary for the production of these resources pose risks to air, water, landscapes, and ecosystems.

The National Ground Water Association hosted workshops in 2014 and 2017 to bring together groups of researchers to assess the understanding of potential groundwater risks from fracking, and recommend future research. The meetings identified two primary environmental risks to shallow aquifers: 1) stray gas associated with shale wells, and 2) groundwater contamination from surface spills of frack chemicals and produced fluids. Induced seismicity from the disposal of fracking wastewater down underground injection control (UIC) wells is another risk, but does not directly affect groundwater. Many of the perceived risks amplified in the media are due to a lack of data, which is driving unsupported arguments on both sides.

Several field studies have provided evidence that gas or frack fluid do not migrate upward from hydraulic fractures into overlying aquifers. Groundwater and surface water contamination is caused by surface spills and leaks of frack chemicals and produced fluids, both at production sites and UIC wells. Stray gas in groundwater has been statistically linked to shale gas wellbore integrity problems, and induced seismicity has been detected from both the fracking process and the disposal of produced fluids down UIC wells.

Data gaps and science needs identified in the workshops include ongoing challenges gaining access to field sites, uncertainties about the origins and migration pathways of stray gas, and the introduction of new frack chemicals with unknown degradation pathways and breakdown products. Non-standardized sampling and analytical methods make comparison of results from different studies challenging. Recommendations include improved data-sharing, and developing standardized methodologies.

FACILITATING TRIBAL CLIMATE CHANGE ADAPTATION PLANNING AND COMMUNICATING CLIMATE CHANGE IMPACTS IN THE GREAT PLAINS

James Rattling Leaf, Sr.
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The purpose of the Great Plains Tribal Water Alliance project is to facilitate, communicate, and put in motion Tribal climate change adaptation planning, by providing training and educational resources, tools and resources, to assist tribes in the planning process, and use case study examples of tribes in Great Plains region of the country addressing climate change impacts through adaptation. The partnership includes the Rosebud Sioux Tribe, Oglala Sioux Tribe, Standing Rock Sioux Tribe, Flandreau Santee Sioux Tribe, Louis Berger, High Plains Climate Science Center, National Oceanic and Atmospheric Administration, National Integrated Drought Information System and the National Drought Mitigation Center.

A BRIEF STATUS REPORT – A CHANGING CLIMATE

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The subject of Climate Change is gathering increased attention in multiple areas as the earth continues to warm and the predicted impacts on our environment are starting to become more apparent. The science is complex and impacts are broad making it difficult for many to devote enough time from busy schedules to "get their head around it". Opinions concerning what is really happening and what if anything should be done are often formed from pieces of information gathered as time allows.

This brief status report is designed to give a broad current snapshot of some of the many different aspects of this complicated topic. It will contain some of the latest information on the status of observed changes to world air and sea temperatures, ocean acidification, sea levels, the cryosphere, and greenhouse gas emissions / concentrations and some of the impacts of those changes. Recent technology and political changes will be discussed as well as policies and methods useful in driving down the emissions of greenhouse gases. The levels of concern of people in the U.S. have been measured in some detail over the years and they will be discussed and summarized.

THURSDAY, APRIL 19, 2018
SESSION 2A
10:20 A.M. – 12:00 P.M.

CHANGES AND DISCOVERIES
(ALPINE ROOM)

UNDERSTANDING THE RELATION BETWEEN ENERGY AND WATER IN THE WILLISTON BASIN

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The Williston Basin has been a leading source for domestic oil and gas production since the 1950s and underlies 135,000 square miles in Montana, North Dakota, and South Dakota in the United States and Manitoba and Saskatchewan in Canada. Today this region, which includes the oil-producing Bakken and Three Forks Formations, is in the midst of a modern energy boom, driven by advances in oil and gas development methods. More than 1 million barrels of oil are produced daily. Even larger volumes of hyper-saline water are produced with the oil and transported to deep disposal wells. Large volumes of freshwater are needed to hydraulically fracture and maintain oil and gas wells.

Multiple ongoing U.S. Geological Survey (USGS) projects are focused on energy and water in the Williston Basin. These projects address brine contamination of shallow groundwater, wetlands, and streams; modeling changes in groundwater geochemistry; characterizations of surface- and groundwater chemistry; estimation of water use for energy development; and groundwater availability in the Williston Basin. Integrating the results from these USGS projects can provide a comprehensive understanding of the various issues to consider when managing energy and water resources in the Williston Basin.

MULTI-PHYSICS AND MULTI-MODEL REGIONAL CLIMATE MODEL ENSEMBLES TO ASSESS CLIMATE RESILIENCY IN THE GREAT PLAINS

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Shifting climate in the Northern Great Plains is expected to have significant impact on regional infrastructure as observed in recent extreme weather events. Recent attention on global levee failures from flooding during times of drought, wildfire and impacts on agriculture, have shown the urgency of assessing the fragility of civil infrastructure that was designed for a different climate than will be in place at the end of the infrastructure design life. Extreme heat and cold events already cost US highway departments billions of dollars each year in pavement maintenance and rehabilitation. Likewise, these events also impact the agriculture and energy sectors as heating and cooling demands change and the environment for livestock, crops, wildland fire, and pests are altered.

Here, we present projected impacts of 21st century climate change on the Northern Great Plains region using a set of regional-scale modeling ensembles including dynamically-downscaled NCAR-C3WE WRF simulations and statistically-downscaled Localized Constructed Analogs (LOCA) and Multivariate Adaptive Constructed Analogs (MACA) climate projections based on CMIP5 ensemble members to illustrate the range of possible climate outcomes. Emphasis will be given to potential changes in extreme event frequency and changing distributions of temperature, precipitation and storm frequency over the Great Plains as hazards to civil infrastructure and agricultural fragility.

CHANGE-POINT ANALYSIS FOR NATIONWIDE PEAK STREAMFLOW

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Traditionally, for many types of analysis, peak streamflow has been assumed stationary, that is it varies around a constant mean within a particular range of values according to a defined variance. In recent decades, concerns about the effects of potential climate and land-use changes, as well as a better understanding of natural climatic shifts in precipitation, have caused a reexamination of the assumption of stationarity, which is fundamental for flood-frequency analysis. These changes, whether natural or anthropogenic, also may result in violations of assumptions for trend analysis. Change points in peak streamflow time series are one type of violation of the stationarity assumption and can result in non-linear/non-monotonic step trends. To better understand the extent of change-point nonstationarities across the Nation, the authors are undertaking a study of change-point methods and the occurrence of change points in the U.S. Geological Survey peak-streamflow database. This presentation 1) defines nonstationarities that occur as change points, 2) presents a comparison of change-point detection methods and some considerations for choosing methods, and 3) presents some results for a nationwide study of change points in peak-streamflow records. Example sites are used to highlight nonstationarities and their implications for flood-frequency or trend analysis.

USING SURFACE AND SUBSURFACE GEOLOGY TO ESTIMATE THE TRUE ELEVATION OF SUBTERRANEAN LAKES AT JEWEL CAVE, SOUTH DAKOTA

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In 2014, volunteer cave explorers discovered the first underground “lakes” in Jewel Cave, located in the southern Black Hills of South Dakota. The lakes occur where cave passages intersect the Madison aquifer. However, the cave survey is not adequate for establishing the true elevation of the lakes. Even though internal loop closures and over 30 cave-radio locations have been used to control lateral errors, there is no way to confidently control vertical errors that might have occurred over thousands of survey shots between the lakes and the nearest certain vertical control.

Over the last 20 years, Jewel Cave National Monument had conducted extensive geological mapping of the Minnelusa Formation in the southern Black Hills. The work has identified six subunits within the Minnelusa that demonstrate remarkable consistency in thickness and lithological identity for hundreds of square miles. In order to estimate the lake elevation more accurately, the park is using the thicknesses of the Minnelusa subunits, as well as its knowledge of stratigraphically controlled levels, to estimate the lake elevations to within 20 feet (6 m). Although this is an approximation, it provides the best possible estimate, short of an actual observation well.

The recent discovery of cave lakes provides a unique opportunity to monitor variations in water level within the aquifer, which is especially important because Madison wells are quite sparse in the southern Hills. This new source of information can significantly improve modeling of the aquifer, and establish natural trends within the system, but only if the true lake elevations are known. Although this study has shown that the cave survey has drifted more than 70 feet (20 m) lower than the actual depth, the stratigraphic estimate will reduce the uncertainty to within 20 feet (6 m).

DETERMINATION OF THE POTENTIAL FOR DETECTION AND MONITORING OF BRINE SPILLS IN RANGELAND USING REMOTE SENSING

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The Williston Basin in Northwestern Great Plains is a principle source of oil, gas, and coal production for the United States since the 1950s. One of the byproducts of oil and gas extraction in this region is highly saline brines. Surface releases and spills of these brines cause changes in soil salinity that can go undetected through traditional methods while degrading grassland productivity, altering native plant communities/diversity, and allowing a foothold for invasive species. These leaks can come from any portion of the extraction system including but not limited to wells, pipelines, storage structures, and even containment ponds. Small releases of brine have a cumulative effect on the surrounding soils and grasses in the region by changing localized salinity thereby becoming an abiotic stressor. As an abiotic stressor there is the potential for the use of remotely sensed imagery to detect change in vegetative health in regions of high alkalinity versus unaffected vegetation. The goal of this NASA EPSCoR funded project is to determine the feasibility as well as the spatial, spectral and temporal resolution at which remotely sensed data can detect vegetation stress from impact of brine releases. A combination of remotely sensed imagery from different sensors will be used to determine attempt to determine green up, “maximum greenness”, and senescence for the determined impacted areas both pre and post spill. A variety of techniques will also be investigated including vegetation indices analysis, band ratios, and change detection. Potential locations will be determined from South Dakota Department of Environment and Natural Resources (SD DENR) National Pollutant Discharge Emission System (NPDES) records and brine composition from SD DENR oil and gas permitting records. The final outcome is to develop a remote methodology to identify and monitor brine spills in grasslands or agricultural systems that would otherwise go undocumented.

THURSDAY, APRIL 19, 2018
SESSION 2P
10:20 A.M. – 12:00 P.M.

WATER QUALITY AND MONITORING
(PONDEROSA ROOM)

IMPACT OF MOUNTAIN PINE BEETLE INFESTATION ON SURFACE WATER QUALITY WITHIN THE UPPER RAPID CREEK WATERSHED OF THE BLACK HILLS NATIONAL FOREST

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The recent outbreak of mountain pine beetle (MPB; *Dendroctonus ponderosae*) in the Black Hills National Forest (BHNF) resulted in nearly 20 million dead trees and decomposition of approximately 2.4 million tons of above ground biomass. Monthly surface water samples were collected from 26 sub-basins during the 2017 field season encompassing both MPB unimpacted and impacted sites within Rapid Creek and Spring Creek watersheds. Results from water quality analyses suggest statistical differences between MPB impacted and unimpacted watersheds exist with respect to the export of sodium (Na), sulfate (SO_4), magnesium (Mg), and dissolved organic carbon (DOC). This presentation will summarize the field and analytical findings for the sampling sites, and will provide a better understanding of the relationships between MPB impacts, hydrologic responses, and surface water chemistry changes for sustainable watershed management.

BLUE DOG STATE FISH HATCHERY (SFH) WATER QUALITY IMPROVEMENTS CONDUCTED FOR SOUTH DAKOTA DEPARTMENT OF GAME, FISH, AND PARKS

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The project was to evaluate and recommend water quality improvements to enhance the reliability of the operation of the Blue Dog SFH. The improvements focused on essentially three items; 1) manganese reduction of the hatchery groundwater source water which was limiting water capacity and increasing maintenance, 2) protection of the SFH and its rearing ponds from invasive species of mussels (Zebra and Quaga) and 3) decontamination of equipment, vehicles, etc. to protect from introduction or transmission of aquatic invasive species (AIS) to or from Blue Dog Lake and the SFH.

A pilot study was conducted to determine manganese removal effectiveness using conventional treatment using chemical oxidation and filtration with various filter medias and also a biologically active filter treatment option. Improvements for exclusion of the invasive mussels to the SFH evaluated thermal and chemical treatment to kill the species, as well as physical exclusion options such as with screening. Options for decontamination of equipment, vehicles, etc. to protect from introduction or transmission of AIS included thermal and chemical alternatives.

The piloting demonstrated biological manganese reduction was very successful and would not require adding chemical oxidants. This was a highly desirable result, as addition of chemicals could impact the fish hatching process and introduce potential for overfeeding of chemicals which could be catastrophic to the hatchery aquatic life. The most effective means of exclusion of the invasive mussels recommended using fine drum filters to screen the lake source water prior to entering the SFH or rearing ponds. The recommended alternative for decontamination of equipment, vehicles, etc. was thermal, using a high temperature, high pressure wash system, again, minimizing the use of chemicals. Preliminary designs and planning level costs were provided to SDGFP for budgeting purposes. Pending funding availability, design and construction of the recommended improvements will progress.

ENVIRONMENTAL MONITORING: APPLYING ADVANCEMENTS IN INSTRUMENTATION TO OVERCOME UNIQUE CHALLENGES

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RESPEC has been involved in various environmental monitoring projects throughout the United States. Our team members have developed multiple custom solutions tailored to our clients' specific location and data collection needs. Because monitoring sites are often remote, making time-sensitive adaptations to data collection protocols or equipment malfunction can be difficult. Recent technological advances have made monitoring and retrieving data in real-time remotely, which can dramatically improve the quantity and quality of reliable data, more cost effective. This presentation will provide an overview of the custom technologies that the RESPEC team has developed and deployed as well as examples of lessons learned.

RAPID DEPLOYABLE REAL-TIME MONITORING TECHNOLOGY FOR WATER RESOURCE DATA COLLECTION

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The North Dakota State Water Commission (NDSWC) has developed a real-time monitoring communication hardware and software platform that allows for rapid deployment, has a small footprint, and is cost-effective.

Collection of water resource data in real-time allows water managers to make regulatory decisions in an efficient manner and maximize beneficial use of waters-of-the-state while protecting the rights of senior appropriators and the public interest. Although the NDSWC partners with the USGS in the operation of their 158 permanent monitoring locations that provide long-term period of record and statistical data for major streams and aquifers in North Dakota, the NDSWC real-time monitoring initiative is intended to complement the USGS stream gage and observation network by providing additional real-time information at points of interest on both major and minor streams or aquifers in the state. The real-time initiative is part of Governor Doug Burgum's directive of stepping up the state's game in the use of technology at all levels of state government operation.

The non-proprietary hardware uses cell radio internet technology within a secured private network to deliver real-time data from connected sensors directly to a web accessible public water resource database. Measurements of water levels within a well or stream using pressure transducers, as well as a number of other environmental data from multiple widely available sensors on the market can be stored and transmitted for use in regulatory decision making and public access. The design allows for expandable input channels should sites of interest require additional data measurements, for example, weather and soil parameters.

The communications equipment is designed to fit into a fence-post mountable 8" x 8" NEMA enclosure with connections for a solar panel, antennae, and multiple external sensors allowing for quick field setup. Currently, sensors collect barometric pressure, air temperature, date, time, system voltage and water pressure. Data signals are recorded on internal memory and delivered to the SWC database at user selectable frequencies as low as every minute. The system health of the devices is remotely monitored and programming can be modified through the cellular network minimizing the need to send personnel into the field. The sub-$1000 price point make these attractive candidates for ubiquitous monitoring even in remote locations.

THE PATH FORWARD – INSIGHT FROM DIRECTED STATEHOLDER DISCUSSION AT THE 2017 EASTERN SOUTH DAKOTA WATER CONFERENCE

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Attendees at the 2017 Eastern South Dakota Water Conference were recently challenged to help explore the current status and determine what the future holds for water resources in eastern South Dakota. The conference was arranged with the morning session featuring agency personnel giving an overview of how water data is collected in the state and the current status of South Dakota's water resources. The afternoon session consisted of stakeholders building consensus around six questions to paint a picture of what success looks like and what actions individuals and groups need to take to achieve success. Four common themes emerged: education and awareness; collaboration, communication, and partnerships; policy, standards, and regulation; and funding. While impaired water quality and non-point source pollution are major issues impacting South Dakota water resources, addressing the four major themes present a greater challenge because that will determine success or failure in making measureable improvement in water quality and non-point source pollution. Action items were developed for each theme and a case study presented. These four themes are relevant to the action plan and decision making process of virtually any entity that deals with water issues.

THURSDAY, APRIL 19, 2018
LUNCHEON
12:00 – 1:30 P.M.

JOHN T. LOUCKS DISTINGUISHED LECTURE:
JEFF CROCKETT
"COLORADO SPRINGS UTILITIES WATER TREATMENT SECTION RESPONSE TO THE WALDO CANYON FIRE"
(RUSHMORE F ROOM)

COLORADO SPRINGS UTILITIES WATER TREATMENT SECTION RESPONSE TO THE WALDO CANYON FIRE

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The purpose of this presentation is to share information and lessons learned by the Colorado Springs Utilities Water Treatment Section in regards to the Waldo Canyon Fire in Colorado Springs. The Waldo Canyon Fire occurred in the summer of 2012, destroying 346 homes and forcing the evacuation of over 33,000 people in the Colorado Springs area. Three water treatment plants had to be evacuated, yet summer demands continued to be met.

This presentation is geared for professionals in the water industry, but is relevant to many different fields and areas of study. It will share many lessons learned during the fire, as well as what a community should prepare for after a wildfire. It will highlight some important emergency preparedness considerations for water departments as well as for any facility. It will also highlight some design considerations for treatment plant design engineers.

In 2017, there were major wildfires burning in Montana, California, and South Dakota, so this presentation is relevant to current issues in the region. Many of the lessons learned are transferrable to any type of emergency situation.

THURSDAY, APRIL 19, 2018
SESSION 3A
1:30 – 3:10 P.M.

EMERGENCY RESPONSE
(ALPINE ROOM)

MUNICIPAL WATERSHED WILDFIRE HAZARD MITIGATION ASSESSMENTS

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Wildfires burn vegetation and alter soil properties, which causes rainfall to run off rather than soak into the soil. Without vegetation and root systems, landscapes can easily erode; consequently, in burned watersheds, rainfall often produces floods that carry debris, sediment, ash, and contaminants, which can affect water supplies. Sediment can fill reservoirs and decrease storage capacities, and debris, sediment, ash, and contaminants can lower water quality and make water more difficult to treat, which causes unwanted tastes and odors. Santa Fe, New Mexico, and Denver, Colorado, have spent $9 million and $26 million, respectively, to treat impacted drinking water after wildfires affected their municipal reservoirs' watersheds.

With the frequency and intensity of wildfires increasing, communities that rely on surface water from forested, fire-prone watersheds are beginning to address the potential for post-fire impacts to water supply reservoirs. Wyoming's Governor Matt Meade commissioned Municipal Watershed Wildfire Hazard Mitigation Assessments (HMAs) for Cheyenne and Buffalo, Wyoming, which source their drinking water from watersheds in the Medicine Bow-Routt Forest and Bighorn National Forest, respectively. Several western, South Dakota municipalities source their drinking water from watersheds in the Black Hills National Forest, and these HMAs are being presented as case studies for preemptively mitigating wildfire threats to municipal water supplies.

The HMAs identified locations for site-specific forest management treatments that can minimize impacts to municipal water sources and facilities after forest fires have occurred. The HMAs focus on the technical analyses of expected wildfire impacts (i.e., FLAMMAP fire-behavior modeling) and the post-fire hydrologic response (i.e., NOAA/USGS Debris Flow Task Force regression models) to identify areas with a risk to the municipal water supply. A prioritization matrix was developed to rank potential treatment locations based on the hazard analyses and factors that are related to project implementation and current forest-management plans (e.g., permitting, habitat, and operability). The HMA results are currently being incorporated into forest-management planning.

The HMAs were funded through the governor's office in Wyoming, administered by the Wyoming Water Development Office, and executed by the RESPEC/Anchor Point Group project team. Collaborating entities included but were not limited to the Cheyenne Board of Public Utilities, City of Buffalo, Wyoming State Forestry Division, Wyoming Game and Fish Division, US Forest Service, and US Bureau of Land Management.

WALDO CANYONE FIRE
IMPACTS TO US 24 & EMERGENCY RESPONSE PLAN

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Before the Waldo Canyon Forest Fire, runoff from areas upstream of US Highway 24 (US 24) was safely conveyed beneath the highway. The fire substantially altered the watershed hydrology and caused runoff rates and debris flow volumes to increase dramatically. This change to the watershed hydrology resulted in several highway overtopping events, which caused extensive roadway damage, frequent road closures, and safety concerns for travelers.

The Colorado Department of Transportation (CDOT) requested RESPEC to assist with mitigating the adverse impacts. RESPEC was tasked with conducting a hydrologic analysis of the burned watershed upstream of US 24, designing infrastructure improvements to minimize adverse impacts to the highway, and helping to develop an emergency response plan (including a roadway-closure protocol) to protect motorists. The plan detailed how CDOT monitored and responded to various flooding events. CDOT's primary focus was to maintain public safety while keeping US 24 open to traffic as much as possible. The presentation will focus on the roadway-closure protocol and a summary of the design improvements and their performance.

CLIMATE AND WEATHER CONDITIONS GOVERNING THE EXPLOSIVE GROWTH OF THE LEGION LAKE WILDFIRE

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The Legion Lake wildfire started on December 11, 2017 consuming more than 54,000 acres over the following 6 days. As the third largest wildfire on record in South Dakota history and the largest fire to occur during the month of December, this wildfire demonstrates that the era of the 12-month wildfire season is upon us. Often, drought is thought to be the primary influencing variable for large fire growth but recent research demonstrates that wildfires within the Black Hills during December may not be dependent on drought conditions. The local meteorological and fuels factors are, however, of utmost importance in determining the potential for cold-season wildfires in this Ponderosa Pine-dominated ecosystem. Furthermore, “classic” critical fire weather conditions (i.e. those meeting Red Flag Warning criteria) are not necessary and were largely absent during the duration of explosive wildfire growth. This presentation will explore these environmental factors and discuss the implications for wildfire management in a changing climate.

CHRISTMAS LAKE DAM HYDRAULIC ANALYSIS AND REDESIGN

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Christmas Lake Dam, also referred to as Canton Dam, is located on the eastern edge of Canton, SD. The contributing area for Christmas Lake Dam is 3.5 square miles with a total dam height of 27 feet. In June of 2014, areas of southeastern South Dakota received extensive rainfall amounts resulting in high runoffs, including the Christmas Lake Dam drainage basin. This high runoff resulted in significant auxiliary spillway flow and substantial erosion damage on the exit slope of the auxiliary spillway. This occurrence triggered the re-evaluation of the hazard category for Christmas Lake Dam and the frequency storms the dam needs to pass to meet hydrologic criteria in South Dakota. To assess the hazard category, a hydrologic model using HEC-HMS and breach analysis using HEC-RAS was conducted by HDR for Christmas Lake Dam to determine potential damage scenarios downstream should a failure of the dam occur. The analysis created a breach hydrograph based on an assumed failure mode and developed a flow-through scenario assuming no dam is in place. The hydrographs were routed from the dam downstream to its confluence with the Big Sioux River. The results of the analysis indicated that the dam may cause damage to buildings, highways, railroads, drainage crossings, and public utilities, but loss of life is not expected. Therefore, HDR recommended to maintain the current dam classification of a small category 2 dam. HDR then developed plans and specifications for repair of the damaged dam. Design included the replacement of the principal spillway weir structure, replacement of the principal spillway conduit, rerouting of the auxiliary spillway channel, development of a downstream plunge pool, and realignment of existing City utilities.

BIOFILM ENGINEERING APPROACHES FOR IMPROVING THE PERFORMANCE OF BIOELECTROCHEMICAL SYSTEMS FOR BIOREMEDIATION OF INDUSTRIAL EFFLUENTS

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Bioelectrochemical Systems (BES) are electrochemical devices that make use of the complex enzymatic machinery of electroactive microorganisms and their electron transfer characteristics for mediating bioelectrocatalysis. BES make use of the electrocatalytic activity of the electroactive microorganisms and can either convert chemical energy into electrical energy as in the case of Biological Fuel Cells or can convert electrical energy into chemical energy as in the case of Microbial Electrolysis Cells. BES are promising strategies for the simultaneous treatment of effluents in addition to other applications such as production of biofuels (bioelectricity, biohydrogen, methanol, biodiesel) and value-added compounds. The use of BES for treatment of different effluents have several advantages over the conventional remediation strategies because of its low cost, eco-friendly nature, high conversion efficiency and mild operating conditions.

Herein, we discuss the different configurations of BES such as concentric, two compartments and three compartmental BES developed in our laboratory for the treatment of different effluents such as glucose, ethanol, and acetate containing synthetic wastewaters, distillery effluents, winery effluents and tannery effluents. Their performance of the BES in terms of cell voltage, COD removal rate, power density, and coulombic efficiency will be discussed. The presentation will address biofilm engineering strategies for improved bioelectrocatalysis by tailoring the surface architecture of electrodes using biopolymers, nanomaterials, and conducting materials. Functionalization strategies will increase biocompatibility for improved biofilm engineering and will increase conductivity for improved electron transfer characteristics at electrode-electrolyte interfaces.

THURSDAY, APRIL 19, 2018
SESSION 3P
1:30 – 3:10 P.M.

GROUNDWATER
(PONDEROSA ROOM)

GROUNDWATER CONDITIONS IN THE ARARAT BASIN IN ARMENIA

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Armenia is a landlocked country located between Asia and Europe. Groundwater supplies 96 percent of the water used for drinking water purposes and about 40 percent of all water withdrawn in the country is from groundwater. Since 2000, aquaculture demands and other uses have increased groundwater withdrawals in the Ararat Basin (Ararat Valley) in Armenia. Increased groundwater withdrawals in Armenia resulted in decreased springflows, reduced well discharges, lower well water levels, and a reduction of the number of flowing artesian wells in the Ararat Basin.

In 2017, the U.S. Geological Survey (USGS) completed a report (https://pubs.er.usgs.gov/publication/sir20175163) in cooperation with the U.S. Agency for International Development describing the hydrogeologic framework and groundwater conditions of the Ararat Basin in Armenia, with the focus of this abstract on the groundwater conditions.

In 2016, using training provided by USGS, Armenian partners completed an inventory of approximately 2,800 wells completed in and around the Ararat Basin in Armenia. Historical water-level data were acquired from Armenian partners for determining groundwater-level changes over time. Potentiometric contour maps were developed for four hydrogeologic units in the Ararat Basin based on water-level data from the 2016 well inventory.

Data obtained during the well inventory were used to generate a map showing nonflowing and flowing wells in the Ararat Basin. The nonflowing aquifer conditions were on the edges of the Ararat Basin where the basin depth shallows. The artesian conditions and the cold water allowed Armenian aquaculture industries to utilize the naturally flowing artesian conditions to sustain fish farm operations.

Data collected from the 2016 well inventory were used to summarize water use in the Ararat Basin in Armenia. The water discharge from the 127 abandoned wells flowing to waste was 1,090 liters per second, which is an annual volume of about 34 billion liters. Most of the abandoned wells flowing to waste (75 percent) had previously been used for fish farming. By water-use category, the largest percentage of the wells (42 percent) was used for irrigation purposes. Fish farming constituted 17 percent of the wells, followed by drinking-household (15 percent), drinking-household plus irrigation (15 percent), and unused (flowing to waste) (7 percent). Over time, the flowing wells under artesian pressure reduced the pressure in the aquifer. As a result, many wells that were flowing have ceased to flow. The area within the Ararat Basin in Armenia with flowing wells (within the pressure boundary) was approximately 619 square kilometers in 1984, but decreased to 291 square kilometers in 2016. This is more than a 50-percent reduction in area between 1984 and 2016.

AIRBORNE ELECTROMAGNETIC (AEM) SURVEYS OF BURIED AQUIFER DEPOSITS IN NORTH DAKOTA

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The North Dakota State Water Commission has recently conducted airborne electromagnetic (AEM) surveys in central and eastern North Dakota to help delineate buried channel aquifers. The surveys, conducted in 2016 and 2017 by Geotech, Ltd., involve a helicopter towing a large hoop-shaped antenna about 100 feet above the ground with flight lines spaced at approximately 400 meters apart. The antenna sends and receives electromagnetic (EM) pulses. From the EM response, effective geophysical properties of sands, gravels, clays, shales, and underlying basement rock can be inferred.

The benefits of AEM are its non-invasive approach to data collection and its ability to collect data over large areas in a very short period of time. The surveys provide high-resolution maps and profiles to identify the complex geometry and depth of the buried glacial aquifers within the survey area. These buried glacial aquifers have no hint of their existence below the relatively flat uniform landscape of the drift prairie and Red River Valley.

The 2016 survey consisted of 1,950 km of flight lines flown over the Spiritwood buried valley aquifer in central North Dakota. The results of the survey exceeded expectations. Not only did the survey provide an image of where the deep channel of the Spiritwood aquifer was located, it also showed there was an even deeper, previously unknown, buried aquifer channel traversing through the study area. Test drilling during the following field season confirmed the existence of this previously unknown aquifer.

The 2017 survey consisted of 2000 km of flight lines flown over the West Fargo and Wahpeton buried channel aquifers in eastern North Dakota. Aqua Geo Frameworks, a hydrogeological consulting firm specializing in AEM data processing, performed advanced processing techniques and methodology. Their work product resulted in valuable 3D imagery and hydrogeological interpretation. Results confirmed known extents of both the West Fargo and Wahpeton aquifers, but also revealed significant additional aquifer deposits in previously unmapped locations where existing lithologic data suggested a buried channel deposit may be present.

The AEM method is a game-changer in groundwater investigations. Massive amounts of data collection can be done in a matter of weeks that with conventional methods (test drilling) would take years. The methodology has the potential to revolutionize hydrogeological investigation in a number of North Dakota's buried aquifer systems.

NUMERICAL SIMULATION OF GROUNDWATER FLOW IN THE HIGH PLAINS AQUIFER SYSTEM IN SOUTHERN SOUTH DAKOTA AND NORTHERN NEBRASKA

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Throughout the Upper Midwest and Great Plains areas, rapidly rising commodity prices are driving dramatic changes towards more intensive agricultural practices aimed at increased crop production. As a result, potential increases in irrigation demand, under current or potentially changing climate conditions such as extreme drought, could result in added stresses to local and regional aquifer systems in South Dakota and northern Nebraska. Potential large-scale irrigation development from the High Plains aquifer system could have important economic implications relative to water-rights issues for the Oglala Sioux Tribe (OST) and Rosebud Sioux Tribe (RST) in southern South Dakota. Future groundwater development in this region requires considerations for balancing irrigation demands and climate variability with complex water-rights processes, sustainability planning, and issues associated with the connection of groundwater and surface water, which are important for the area's wetlands and streams.

The U.S. Geological Survey (USGS) previously completed four sub-regional numerical groundwater flow models for the High Plains aquifer in southern South Dakota. These four groundwater flow models could be used independently for cursory evaluations of increased irrigation demand. However, the sub-regional models include artificial boundaries which could produce an inaccurate representation of groundwater flow near or across the boundaries. However, a regional model that includes data from the sub-regional models will increase efficiency for evaluating the effects of increased irrigation demand and changing climate because it will include natural hydrologic boundaries, such as rivers, streams, and watershed boundaries that will more accurately represent groundwater flow near those boundaries. As a result, the USGS is developing a regional numerical groundwater flow model for the northern extent of the High Plains aquifer system in southern South Dakota and northern Nebraska. The model will be used as a tool to assess potential effects of increased groundwater withdrawal or prolonged drought in the region.

TRITIUM AND CARBON-14 DATES IN THE MADISON LIMESTONE AQUIFER, BLACK HILLS AREA, SOUTH DAKOTA

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Back et al. (1983) dated groundwater in the Madison Limestone using Carbon-14. The age (years before present, YBP) ranges from low values ("modern" at Rhoad's Fork, Jones Spring, and Cleghorn Spring) to high values (8,700 YBP at Upton, 17,300 YBP at Ellsworth AFB, 1,900 YBP at Evans Plunge, ~7,920 YBP at Cascade Spring, and 20,000 YBP at Philip). Assuming the ^{14}C age is the time required for water to flow from the recharge area to the sampling point, Back et al. (1983) determined the hydraulic conductivity of the Madison Limestone ranges from 0.5×10^{-6} m/s to ~24×10^{-6} m/s.

Tritium concentration data was published by Naus et al. (2001). Tritium, a product of H-bomb testing, peaked in 1963; the amount of tritium in water (tritium units, TU) is used by hydrogeologists to determine if recharge occurred before or after year 1963. The groundwater samples in this publication show springs near recharge areas (including Rhoad's Fork, Jones Spring, and Cleghorn Spring) have high tritium concentration (62 TU, 276 TU, and 90 TU, respectively). Since these springs contain high tritium, the water includes precipitation recharged since 1963. The groundwater further from recharge areas (wells such as Newcastle and Osage) have very low tritium concentration (0.1 TU and 0.5 TU, respectively).

The ^{14}C and ^{3}H groundwater data help define a general model of groundwater flow direction and velocity. The water from Cascade Spring and the spring at Evans Plunge (Hot Springs, SD) mostly originates a great distance away because it takes thousands of years to get from the recharge area to the spring. Groundwater from deep wells in the Madison Limestone in the surrounding prairie area has taken tens of thousands of years to flow from its recharge area.

References:

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EVALUTION OF STREAMFLOW DEPLETION RELATED TO GROUNDWATER WITHDRAWALS IN THE HUMBOLDT RIVER BASIN, NEVADA

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The Humboldt River Basin, contained entirely within north-central Nevada, drains an area of about 17,000 square miles and includes nearly 15% of the state's total area. Historically, water users depended on state-allocated withdrawals from the Humboldt River to irrigate farms and ranches and by the 1930's the river was fully allocated. In the 1950's, water users began to develop wells in the Humboldt River Basin to either supplement existing surface water rights or secure new groundwater rights. By the 1980's groundwater withdrawal increased to over 150,000 acre-feet/year (210 cubic feet per second), and by the 1990's large-scale mine dewatering operations generated additional groundwater withdrawal in the basin (estimate to parallel irrigation). Groundwater withdrawals in the basin are suspected to contribute to increasing streamflow depletion, but the specific effects on the Humboldt River are not well understood. To assess the impact of groundwater pumping on the Humboldt River flow, a groundwater flow model is being developed. The analysis will utilize MODFLOW, the U.S. Geological Survey's modular hydrologic model, and simulate Humboldt River streamflow and its gains and losses to the underlying aquifers. Challenges include modeling a braided stream network, simplifying complex river channels, simulating water allocations along the river, and accurately accounting for groundwater used for irrigation and mine dewatering. The completed groundwater flow model will be used to evaluate streamflow depletion from groundwater withdrawals in the basin. This analysis will support the Nevada State Engineer and the Nevada State Legislature in developing conjunctive use regulations for existing and future stream and groundwater withdrawals across the State.

THURSDAY, APRIL 19, 2018
SESSION 4A
3:30 – 4:30 P.M.

GEOMORPHOLOGY
(ALPINE ROOM)

DEVELOPING A HYDROLOGIC MODEL TO STUDY THE EFFECTS OF HABITAT RESTORATION AND THE CHANGE IN HABITAT ON AQUATIC LIFE

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Black Hills streams have been a primary habitat for salmonid fishery, wild brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*). Recently, a stretch of Rapid Creek, has experienced high water flow releases from Pactola Reservoir causing erosion and subsequent reduction in hiding spots/spawning areas for brown trout and other fish. An extensive habitat project has been carried out by the Game, Fish, and Parks involving placing boulders across the stream bed and burying wind-fallen trees along banks to encourage the productivity of trout fisheries. A two-dimensional hydraulic model, River2D, will be used for hydraulic and habitat analysis. The modified post-construction stream habitat will be compared to pre-construction stream habitat using modeling and field observation to evaluate the effects on stream hydraulic parameters and stream habitat. The results from this research will be used to guide future habitat restoration by providing an accurate estimate of how stream morphology will impact existing habitats. The objectives for this project are; (1) Collect pre-and post-development stream cross-section data through surveying. (2) Create a pre-and post-development River2D model to analyze the effect of habitat restoration projects on hydraulic parameters. (3) Identify data that has been collected on depth, velocity, stream flows and fish distribution in space and time, and use this data to calibrate the models. (4) Assess the success of implemented habitat structures and their benefit to the streams habitat. (5) Use modeling results and field observation to guide future fish habitat restoration projects.

BANK ACCRETION IN THE GREEN RIVER (UTAH) DOWNSTREAM OF THE FLAMING GORGE DAM AND YAMPA RIVER CONFLUENCE

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Rivers and streams subjected to modified hydrology and/or sediment feed rate regimes can undergo several modes of geometric adjustment: (a) longitudinal slope adjustment; (b) alteration of bed material composition; and (c) cross-sectional geometry adjustment. Of the three modes of adjustment, cross-sectional geometry adjustment is subject to the greatest uncertainty. The current study aims to shed light on the conditions under which bank accretion is a viable mode of cross-sectional geometry adjustment, with the ultimate aim of making *a priori* predictions. The 30-km study reach is a low-gradient, sand-bedded portion of the Green River downstream of both the Flaming Gorge Dam and the Yampa River confluence; both the hydrology and sediment feed regimes have been altered relative to the pre-dam condition. Aerial photograph analysis for the years 1997 and 2015 revealed that the expected positive relationship between river width and bank accretion sites was not realized. Rather than the properties of the river at channel-width scale or bar-unit scale, the only identified suitable predictor for locations of bank accretion sites was at a local scale, the 30-m by 30-m pixel size associated with Landsat imagery analysis. The large bank accretion sites all occurred within pixels having a high temporal probability of emergent bar presence during the base flow season. In this very dynamic, braided river system, sites that consistently contain emergent bars are interpreted as depositional areas associated with strong river geometry forcing conditions. While a one-dimensional (1D) modeling framework for predicting bank accretion using coarse state variables such as channel width would be ideal for simplicity, the findings reveal that making such predictions outside of a two-dimensional (2D) modeling framework does not currently appear tractable.

COMPARISON OF GEOMORPHIC PROPERTIES BETWEEN FUNCTIONAL PROCESS ZONES IN THE GREAT BASIN

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From a watershed and stream management perspective, functional process zones (FPZs) are potentially a way for ecosystem and watershed managers to identify specific river reaches based on research interest or project needs. For this study, FPZs were classified and mapped along three rivers in the Great Basin (USA) using a GIS protocol. River reaches within the resulting FPZs were sampled based on the modified EMAP protocol to test whether significant hydrogeomorphic differences existed across scales, including between FPZs, within a single river basin, and among river basins in the Great Basin region. Within a single river basin the geomorphologic characteristics of each FPZ type are significantly different. A comparison of geomorphologic metrics between the same FPZ types and between watersheds revealed significant similarities between the same FPZ types across multiple watersheds. Finally, comparing geomorphologic characteristics within FPZ types across the Great Basin showed significant differences between FPZs. Our study reveals both a substantial amount of internal complexity among FPZs within a river and consistency in the morphological nature of FPZs between rivers within an ecoregion. From a watershed management perspective, the ability to predict hydrogeomorphic processes at the watershed scale is beneficial for cost-effective and standardized management and research goals. From a macro-ecological perspective, this analysis reveals how aggregation of data at larger spatial extents can illuminate patterns that might otherwise be obscured by limiting analyses to finer scales.

THURSDAY, APRIL 19, 2018
SESSION 4P
3:30 – 4:30 P.M.

HYDROLOGY POTPOURRI
(PONDEROSA ROOM)

THE COMPLEXITY OF WATER SUPPLY CONVEYANCES

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Water use and water appropriations have always been a debated topic and tensions continue to grow in subsequent years. With the growing demand and concerns about safe drinking water, the USGS has built a database using data that is collected every 5 years as part of the National Water Census and uses conveyances to track water from its source (wells, rivers, lakes, reservoirs) to distribution centers (cities, mobile home parks, rural water districts). Tracking water usage requires an extensive system of permitting and reporting. Water supply can cross basins, legal boundaries, and potentially international boundaries thus affecting the water balance in the basin and may cause political discussions over water rights. Each state varies in their degree of monitoring and permitting of their own water users. Occasionally a water user is supplied water from out of state which can be difficult to track if there is not a complete record on both sides of the state line. To better understand where water moves, or is conveyed, this presentation will 1) discuss the complexities of gathering information on water usage, 2) the building of conveyances between sites, and also 3) obstacles that could be encountered in the future.

SUBSURFACE CAVE DETECTION IN WIND CAVE NATIONAL PARK USING MICROGRAVITY SURVEYING TECHNIQUES

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Microgravity surveying techniques were used to detect undiscovered cave passageways near Persistence Cave in Wind Cave National Park, South Dakota. The purpose of these surveys was to guide underground exploration efforts by detecting the direction of additional cave networks. Prior to the surveys, GRAVMAG software was used to model the expected gravity variations at the land's surface from known cave geometries. Then, microgravity measurements were made using a CG-5 relative gravimeter along nine survey lines over both known underground caves and in areas adjacent to known caves to prospect for new passageways. The surveys over known caves were conducted to verify the modeled gravity variations. During the prospect surveys, gravity variations ranging from 20 to 50 microgals were encountered northeast of Persistence Cave. These gravity variations were inverse modeled using GRAVMAG software to estimate cave geometries. Results from inverse models suggested that undiscovered cave passageways were northeast of Persistence Cave's entrance and that these passageways likely had geometries similar to those already mapped in the network.

SITE SCALE INTEGRATED DECISION SUPPORT TOOL (I-DST) FOR STORMWATER MANAGEMENT

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Managing Stormwater requires selection of Best Management Practices (BMPs) appropriate for the site and optimizing the design and cost of BMP infrastructure. Creating the balance between grey and green infrastructure has been recognized as a viable approach to address the technical, environmental, social and economic challenges. A Visual Basic Application (VBA) base site scale integrated Decision Support Tool (i-DST) was developed to select the optimized BMPs by considering the different modules. Site scale i-DST is user-friendly tool; selects and optimizes BMPs based on stormwater quality, quantity, treatment efficiency and cost. The tool integrates comprehensive national BMP water quality database, several types of BMPs and treatment efficiencies, capital cost and operation and maintenance cost. The site scale i-DST is intended to help planner, utilities, decision maker and municipalities to evaluate stormwater management options considering economic, environmental, technical and social factors. The input data includes water quality input, target water quality requirements, costs and runoff. The development of site scale i-DST started with the establishment of a comprehensive water quality and quantity database. The site scale i-DST selects most effective BMPs (or a BMP) with respect to technical and economic criteria that could meet the target water quality and flow reduction requirements. The site scale i-DST is a flexible tool allowing users to change weights to BMP selection criteria. Users can also limit the type of BMPs to be included in the selection process to those that are applicable to their site. For existing infrastructure, users can apply site scale i-DST to determine if additional BMPs are needed to meet target water quality or runoff reduction requirements. It was demonstrated through scenario evaluation that the tool recommended cost effective BMPs capable of producing the water quality and flow reduction required for given site-specific conditions and water quality.

THURSDAY, APRIL 19, 2018
POSTER SESSION AND EVENING SOCIAL
4:30 – 7:00 P.M.

(RUSHMORE G ROOM)

MODELING GROUNDWATER FLOW BY COUPLING ENSEMBLE SMOOTHER AND DIRECT SAMPLING METHOD

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Data assimilation plays an important role in groundwater inverse modeling. Ensemble Smoother (ES) is one of the most efficient algorithms applied to the groundwater modeling by assimilating dynamic data (e.g., hydraulic head) to calibrate the conductivity field. However, the ES only works for Gaussian fields, which means the distribution of physical state like hydraulic conductivity needs to follow the Gaussian distribution (Normal distribution). In some curvilinear geometries, like sinuous channels in fluvial deposits, the distribution of hydraulic conductivity is bimodal. Direct Sampling method (DS) is a multiple-point geostatistics (MPS) algorithm which has gained popularity for reproducing the curvilinear structures in fluvial deposits. This paper proposed a new approach to reproduce a bimodal aquifer by coupling ES and DS. Therefore, the hydraulic head data can be assimilated to calibrate the hydraulic conductivity field. To do that, the ES is used to update the conductivities at pilot points using head data; then the updated pilot points will be regarded as hard data to generate the hydraulic conductivity field via DS. The preliminary result shows this new approach can successfully assimilate the hydraulic head data into the model as well as preserving the curvilinear structures.

DYNAMICS OF TEMPERATURE, FLOW, AND THERMAL REFUGE WITH IMPLICATIONS ON FISHERIES AND MACROINVERTERBRATES IN RAPID CREEK

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Increased water temperatures and low flow rates are determined as risk factors for fishery and macroinvertebrate survival. Rapid Creek has established a temperature gradient with increasing temperatures from the tail waters of Pactola Dam to Rapid City. Although the entire section is classified for use as permanent cold-water fisheries, temperature and flow conditions may alter the condition and abundance of the fish. From May to September 2017, temporal and spatial variations of temperature, discharge, and water quality were monitored to examine the effects on fish and macroinvertebrate abundance, density, and biomass in Rapid Creek. The changes in water temperature and water depth indicate the need for thermal refuge for trout to avoid the potential adverse effects to their growth and survival. As the Rapid Creek fishery has declined from class BR1 to BR2 in Pactola Basin and BR3 in lower sections due to decreasing fish abundance, we plan to help elucidate the mechanisms that are limiting the fishery.

EXAMINING STREAMFLOW LOSSES ALONG WHITE RIVER NEAR OGLALA, SOUTH DAKOTA

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U.S. Geological Survey streamflow gages on the White River in Oglala Lakota County, South Dakota, indicate streamflow losses between a gage located near the South Dakota-Nebraska state line and another gage located approximately 16 miles downstream near Oglala, South Dakota. The presence of radionuclides at the western boundary of the Arikaree aquifer near the White Clay fault and the streamflow losses along the White River raise several fundamental questions. For example, where have the streamflow losses gone? What is the role of the White Clay fault in surface water-groundwater interactions along the White River near Oglala? Is the transition zone of the White Clay fault a loss zone? The answer to these questions will advance our understanding of groundwater and surface water interactions that is vital for regional water resource management. In this work, we plan to develop a coupled surface water-groundwater interactions model at the potential streamflow loss zone along the White River, near Oglala. To do that, a geologic cross-section is a critical first step in assessing the lithological and structural characteristics near White Clay Fault. Streamflow and groundwater data will be examined to give insight on potential recharge to or discharge from the Arikaree aquifer. Combining the geological and hydrologic data will yield a better understanding of the surface water and groundwater interaction near the fault. The preliminary results suggest that there is a relationship between geologic structure and streamflow losses in the area. Overall, this study provides a basis for future hydrogeological investigations in the vicinity of the White Clay Fault, and is necessary to produce an accurate surface water and groundwater interaction model.

INVESTIGATING NUTRIENT DISTRIBUTION AND LAND USE IN THE KOOTENAI RIVER BASIN

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Nutrient loading in aquatic environments can have drastic impacts on ecosystems. Phosphorous loading is most often noted due to the resulting toxic algal blooms, but loading of nitrogen can also have detrimental effects. Historically, the Kootenai River was ultraoligotrophic, evident from the low concentrations of nitrogen and phosphorous. However, nitrate levels have been on the rise in the since the mid 2000's, while soluble reactive phosphate (SRP) concentrations are found near or below detection limits. In order to better understand the distribution of these nutrients and the magnitude of the influence of nitrate loading, we completed monthly sampling around the confluence of 8 tributaries to the Kootenai River watershed. Sampling ran from May to October as we collected samples from the main stem 100m above and below the tributary confluence, as well as samples directly from the tributary 100m upstream from the confluence. To further examine the nutrient distribution in the watershed, we synoptically sampled each of the tributaries in July, using similar techniques to the monthly sampling. SRP was consistently low throughout all samples while nitrate concentrations exhibited more variance between different parts of the river. As we hypothesized, the largest contribution of nitrate came from the Elk River, a tributary in British Columbia. If the imbalance of N:P continues to increase due to nitrate loading, the biota may shift within the river leading to a decline in biodiversity

WATER QUALITY COMPARISON OF TWO WATER YEARS AT NIOBRARA NATIONAL SCENIC RIVER

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The National Park Service Northern Great Plains Network (NGPN) initiated long term water quality monitoring in 2013. Since then, NGPN has entered into interagency agreements with the U. S. Geology Survey (USGS) Dakota, Wyoming-Montana, and Nebraska Water Science Centers to collect water quality data. The USGS provides NGPN with approved data for four core parameters (water temperature, specific conductance, pH, and dissolved oxygen) and for streamflow. In addition, data are made available in real-time (i.e., during ice-free season) for the parks sampled that year on the NGPN Website and the USGS National Water Information System website. NGPN collect parameters on a three year rotation at seven park units in our network of parks. Our objective is to determine status and long-term trends of core field parameters in wadeable perennial streams/rivers during the ice-free season for park units in our network. This analysis compares status and trends in core water quality parameters for two ice-free seasons (i.e., 2014 and 2017) at Niobrara National Scenic River in Nebraska, U. S.

SOIL COLUMN EXPERIMENT AND MODELING NITROGEN FATE AND TRANSPORT FROM ON-SITE RURAL SEPTIC SYSTEMS IN THE SOUTH DAKOTA, BLACK HILLS AREA

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The Black Hills area is scattered with over 10,000 on-site septic systems, many located in karst limestone and alluvial sediments. The permissibility of these formations in combination with high water tables presents potential for contamination of groundwater. On-site septic system constituents of concern include nitrogen, phosphorus, viruses and disease-causing bacteria. The heightened levels of nitrate-nitrogen in correlation to the location of clustered systems in the area creates ground water contamination concerns. Conventional on-site septic system construction is not necessarily compatible with every hydrological setting.

The focus of this research is to monitor the transport of nitrate-nitrogen through different soils and observe hydraulic performance. Soil columns will be used to simulate leach fields and results will be compared to modeling software Hydrus-2D and STUMOD. The modeling approach, supported by field and lab data will be used to improve the prediction of nitrogen fate and transport from soil based systems. Vadose zone modeling can also predict cumulative effects of leach fields on public health and environmental quality. The modeling approach supported by field and lab data will be used to improve the prediction of nitrogen fate and transport from soil based systems.

THE IMPACTS OF LAND USE AND LAND COVER CHANGE ON WATER QUALITY IN THE BIG SIOUX RIVER: 2007–2016

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The increasing demands for ethanol and rises in the price of corn led to increase of corn acreage in South Dakota. Other driving forces such as crop insurance subsidies and disaster payments encouraged farmers to (1) convert pasture, fallow, and grassland to corn acreage, and (2) shift from other crops such as wheat to corn. Land use changes are associated with soil erosion and diminished water quality. The impact is greater when the change is because of conversion of grassland to corn cropland. Corn requires a large quantity of N fertilizer which farmers supply using industrial fertilizers. The industrial fertilizers, when supplied in excess, results in the nutrient-rich soils. Leaching of nutrients rich soils during rainfall or irrigation leads to degradation of downstream water quality. High concentrations of nitrates (>10 ppm) are associated with human health issues and are regulated by the United States Environmental Protection Agency. The research uses the National Agricultural Statistic Service-Cropland Data Layer to characterize and determine the rates of Land Use and Land Cover Change change, and the Mann-Kendall test to analyze the temporal and spatial trends of nitrogen levels in the Big Sioux River (BSR) watershed. The results show that the corn/soybean cropland increased from 2007-2016 by 1.9 million acres which was obtained from grassland and other crops. The initial Man Kendall test shows that the percentage of corn/soybean cropland had a upward trend with a tau value of 0.228 (2-sided) and the p-value of 1.8835e-05. Additionally, 6 out of 10 gauging stations showed an upward trend, 2 showed a downward trend, and 2 showed a neutral trend, for the nitrogen trend analysis. Finally, the linear model of the Sen's slopes of nitrates versus the Sen's slopes of percentage corn/soybean and other classes was carried out which gives lower R2 values and p-values.

GENOME TO PHENOME RELATIONSHIPS FOR IMPROVING THE PERFORMANCE OF BIOELECTROCHEMICAL SYSTEMS

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Bioelectrochemical Systems (BES) are electrochemical devices that makes use of the electrocatalytic activity of the microorganisms to convert wastes to bioelectricity. Coupling the BES with waste treatment plants can help in cutting down costs and disposing the wastes in an environmentally benign manner. Different attempts such as engineering new configuration of bioelectrochemical systems, new electrode materials, electrode functionalization strategies, new electroactive microorganisms, genetic engineering, and surface display technologies have been attempted to improve the rates of electrocatalysis. However, these strategies did not significantly increase the rates of microbial bioelectrocatalysis. Herein, we present the use of genome to phenome strategy for increasing the rates and production of polyhydroxy alkenoates. The effect on concentration of methane on surface characteristics of the microorganisms was investigated using microscopy and mechanobiology approach. Further, the effect of the increase surface area of the microbe and its surface characteristics of the microorganisms on the electron transfer kinetics and yield of polyhydroxy alkenoates were analysed. The synthesised biopolymer was used for tailoring the surface architecture of the electrodes to confer biocompatibility and increased rates of electrocatalysis.

FATE AND TRANSPORT OF ANTINEOPLASTIC AGENTS: DETOXIFICATION MECHANISMS IN DRUG-RESISTANT MICROORGANISMS

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Antineoplastic agents are drugs that can inhibit the maturation and proliferation of the cancer cells. Antineoplastic drugs are the emerging contaminants that poses severe threat to the environment. These drugs are released into the environment from residential, hospital, and pharmaceutical industry effluents, and it is one of the burgeoning issue. The release of these emerging contaminants (antineoplastic drugs) in effluent poses a great threat to biota due to their toxicity. These drugs are potent to induce cytotoxic and genotoxic effects not only to patients but also to those who are exposed to these drugs. It remains a challenge to treat these wastes by conventional biological methods because of their toxic and recalcitrant nature. Therefore, it is vital to understand the fate and transport of these contaminants as well as mechanisms of their detoxification by drug-resistant microorganisms. To the best of our knowledge, there is no report on the fate and transport of antineoplastic agents as well as mechanisms of detoxification of these drugs in microorganisms. Herein, we discuss the bioelectrochemical strategies to treat toxic effluents. The drug resistant microrganisms and their detoxification mechanisms were harnessed and used as electrocatalysts in the bioelectrochemical systems. The identified drug resistant microorganisms, their electrocatalytic activity, and the electron transfer kinetics will be presented.

APPLICATION OF DRAINAGE WATER MANAGEMENT AND SATURATED BUFFERS FOR CONSERVATION DRAINAGE IN SOUTH DAKOTA

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Agricultural sub surface drainage has been identified to ease water and nutrient transport from lands with poorly drained soil. The transport and subsequent accumulation of nutrients, such as nitrates in water bodies leads to algal blooms, which is a key stressor to aquatic flora and fauna. Conservation drainage practices such as Drainage Water Management (DWM) and saturated buffers have been implemented to minimize nutrient loads transported to receiving waters. This study aims to quantify the performance of both the practices in study sites across eastern South Dakota. Results from the DWM site at Alexandria show that the nitrate loads per acre for the conventionally drained half are 24.4 % and 41.7 % more than the DWM half for 2016, 2017 respectively. To study the impact of DWM and tile design on nitrate loads, a SWAT project has been setup to simulate DWM at field scale. In addition, two saturated buffer sites were setup near Flandreau and Baltic and analyzed for nitrate reduction. Results show an average nitrate concentration reduction of 85.6% and 58.1% during 2016, 2017 respectively for Flandreau and 95.4% reduction for Baltic, SD. Future work involves completion of calibration/validation of the SWAT project and continuance of water sampling from the research sites for 2018.

DEVELOPMENT OF A GROUNDWATER MANAGEMENT PLAN FOR THE CITY OF ABERDEEN, SD

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The City of Aberdeen, South Dakota is planning to expand its current water supply. In preparation for future droughts and a growing population with increasing demands for water, the city is reassessing its water resources and is planning the construction of new wells to help meet growing water demands. Currently, most of the city's water is supplied from the Elm River. When the streamflow of the river becomes too low, water is pumped from a well field located seven miles north of Aberdeen. These wells were completed in the Elm aquifer, a shallow alluvial aquifer system. To help the city reassess its water resources, the U.S. Geological Survey (USGS), in cooperation with the City of Aberdeen, is currently constructing a newer and more accurate groundwater flow model for study area just north of Aberdeen. This newer model will incorporate the three main aquifers (Elm Aquifer, Middle James Aquifer and Deep James Aquifer), as well as the surficial deposits and the confining layers which underlie each aquifer. Although this new model will be a valuable resource for planning the construction of new wells, little information is available for determining optimal locations for wells optimized for water production, construction cost or other important factors. So the purpose of this study is to use the upcoming USGS groundwater flow model to develop a groundwater management plan for the city. The groundwater management plan consists of a set of hypothetical pumping situations, where each situation describes a well field and a pumping schedule optimized for a certain criterion. Optimization criterions include maximizing water output, minimizing well installation cost, and maximizing surface water to groundwater ratios. The well field optimizations will be determined by coupling the groundwater flow model and Groundwater Management Process (GWM) program. GWM is a groundwater management program developed by the U.S. Geological Survey. GWM uses a response-matrix approach to solve several types of linear, nonlinear, and mixed-binary linear groundwater management formulations. By building groundwater management formulations for each criterion, a set of optimized well fields and pumping schedules can be achieved. The expected result is a set of hypothetical well fields and pumping schedules that the City of Aberdeen can use to optimize their water supply.

FRIDAY, APRIL 20, 2018
FIELD SEMINARS/TRIPS
PRE-REGISTRATION REQUIRED

FIELD TRIP #1: TOUR OF SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY CAMPUS AND LABORATORIES

Description: Tour of various departments and facilities at SDSMT, visit with faculty about research projects, explore recently-completed building renovations. Proposed stops include the Surbeck Center, Civil Engineering Dept., King Center, Paleo research lab, Chemistry building and labs, and Mining and Engineering Management Dept.
Leader: Galen Hoogestraat (USGS) and various SDSMT faculty
Meeting time: 9:00 a.m. to 12:00 p.m.
Meeting location: 9:00 a.m., Surbeck Center, SDSMT campus
Duration: 3.0 hours (3.0 PDH)

FIELD TRIP #2: RAPID CREEK IN-STREAM FISH HABITAT IMPROVEMENT PROJECTS

Description: Visit stream habitat improvement projects completed by SD Game, Fish, and Parks, in Rapid Creek between Pactola Dam and Rapid City
Leaders: Jake Davis and John Carriero (South Dakota Department of Game, Fish, and Parks)
Meeting time: 8:30 a.m.
Meeting location: Canyon Lake north parking lot along Jackson Blvd. Carpool if needed – transportation not provided.
Duration: 3 hours (3.0 PDH)

FIELD TRIP #3: JEWEL CAVE NATIONAL MONUMENT GEOLOGY TOUR

Description: We will begin with a short underground tour of Jewel Cave and then address the Jewel Cave fault and related geological features that led to the formation of Jewel Cave.
Leaders: Mike Wiles (NPS – Jewel Cave National Monument)
Meeting and location:
Black Hills National Forest Service visitor station - 8221 US-16, Rapid City, SD 57702 - HWY16 south of Catron Blvd.
Meet at **7:30 a.m**., carpool to Jewel Cave (vans may also be available).
Or be at Jewel Cave visitor's center by 8:30 a.m. if traveling separately.
Duration: 4-5 hours including travel (3.0 PDH)

FIELD TRIP #4: ORCHARD MEADOWS SUBDIVISION DRAINAGE IMPROVEMENTS

Description: Walking tour of the major drainage improvements recently constructed in Orchard Meadows Subdivision (Rapid City). Improvements to Element 8 include coordination, design, and construction of a 3,600-foot long, 130-foot wide drainage channel, creation of 20 acres of wetland area, relocation of existing 100-year floodplain/floodway, crossing an active irrigation ditch, and several major street crossings. The walking tour is about 1.5 miles.
Leaders: Michael Towey, Kyle Treloar, and Mike Stetson (KTM Design Solutions)
Meeting time: 8:30 am
Meeting location: West end of Lytle Lane – Directly behind Common Cents at Hwy 44/Elk Vale interchange
Duration: 3 hours (3.0 PDH)